Are SUVs Really Safer than Cars?

Berkeley Lab Friends of Science
February 19, 2004

by

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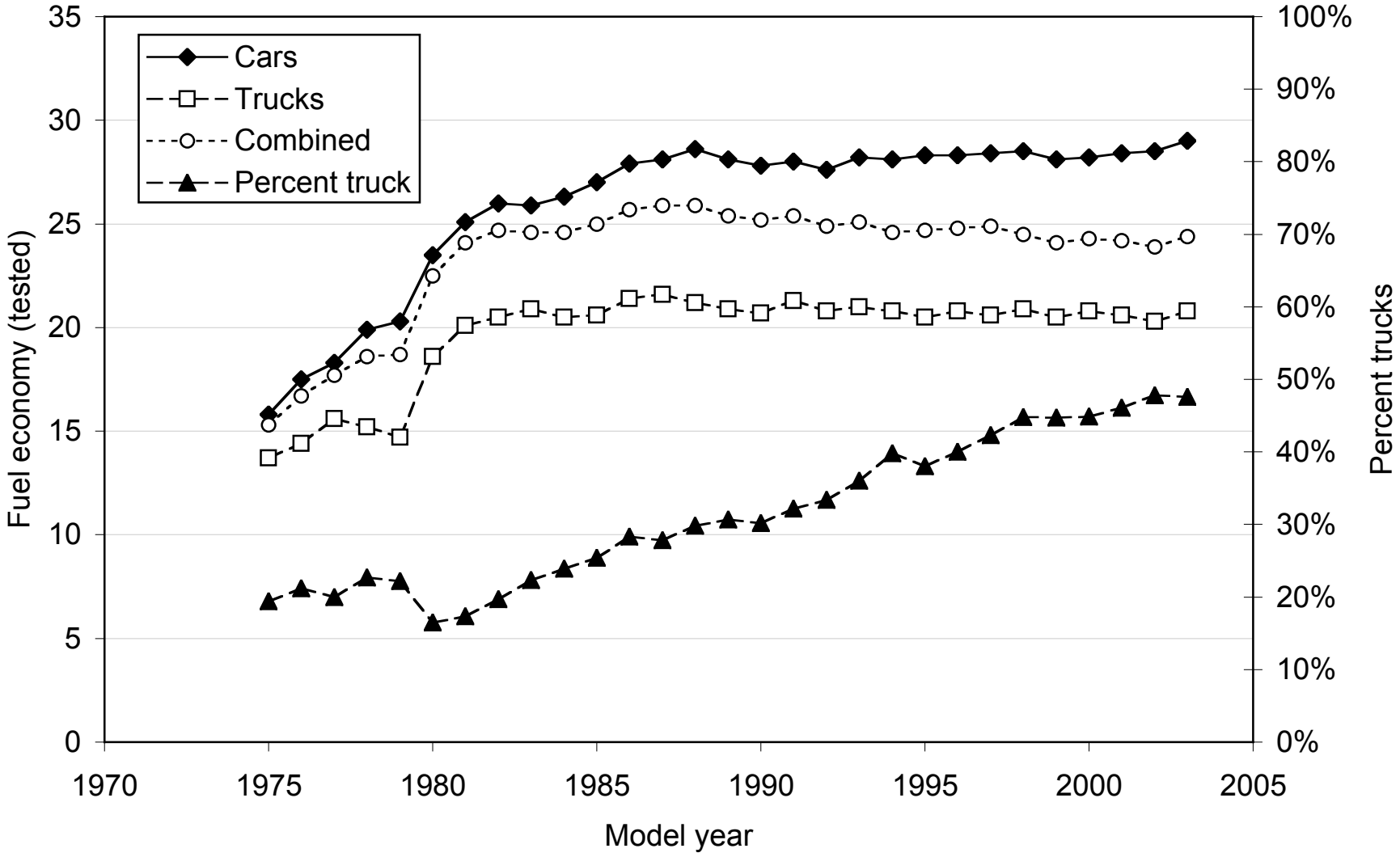
Context: two views of vehicle weight and safety

- Majority of National Academy of Sciences committee on the Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards:
  - "The downweighting and downsizing [of vehicles] that occurred in the late 1970s and early 1980s, some of which was due to CAFE standards, probably resulted in an additional 1,300 to 2,600 traffic fatalities in 1993."
- Minority (two members) of same committee:
  - "The conclusions of the majority of the committee … are overly simplistic and at least partially incorrect … The relationship between vehicle weight and safety are complex and not measureable with any reasonable degree of certainty at present…Reducing the weights of light-duty vehicles will neither benefit nor harm all highway users; there will be winners and losers."
- Does reducing weight inherently increase fatalities, or not?

Corporate Average Fuel Economy (CAFE) standards

- Fleet average mpg standard for every manufacturer
- Separate average for cars and light trucks (pickups, SUVs, minivans, vans)
  - cars = 27.5 mpg
  - light trucks = 20.7 mpg (increasing to 22.2 mpg by 2007)
  - heavier trucks (over 8,500 lbs) exempt
- Loose definition of light truck is a loophole
  - few SUVs taken off-road or used for hauling
  - rear seat can be removed to make flat bed: PT Cruiser, Subaru Forester, new Subaru Outback considered trucks
- National Highway Traffic Safety Administration (NHTSA) requesting comments on the form of CAFE standard by 4/27/2004
  - download proposed rule at: http://www.nhtsa.dot.gov/cars/rules/cafe/rulemaking/ANPRM_Dec-22-2003.pdf
  - send comments to docket number NHTSA-2003-16128 at: http://dms.dot.gov/reports/fr.htm

CAFE declining slightly as percent trucks increases



Definition of risk

- "Risk": driver fatalities per year, per million vehicles registered as of Jan 2002

- Similar to driver fatality rates (IIHS 2000)
  - driver fatalities from NHTSA Fatality Analysis Reporting System (FARS)
    - FARS includes many details on all US traffic fatalities
  - registered vehicles as denominator, or measure of "exposure"
  - IIHS analyzes many more models, over different time periods
    - our analysis limited to most popular models, over same five year period (1997-2001)
  - IIHS only analyzes risk to drivers of individual models
    - we also analyze risk to drivers of other vehicles with which vehicle types or individual models crash (ala Joksch et al. 1998, Gabler and Hollowell 1998)

Definition of risk (cont.)

- Because it is based on actual fatalities, our definition of risk incorporates:
  - —vehicle design
    - crash avoidance (sometimes measured by consumer groups)
    - crashworthiness (typically measured in artificial lab crash tests)
  - —driver characteristics and behavior
  - —road environment and conditions
- Therefore, all risks are “as driven”

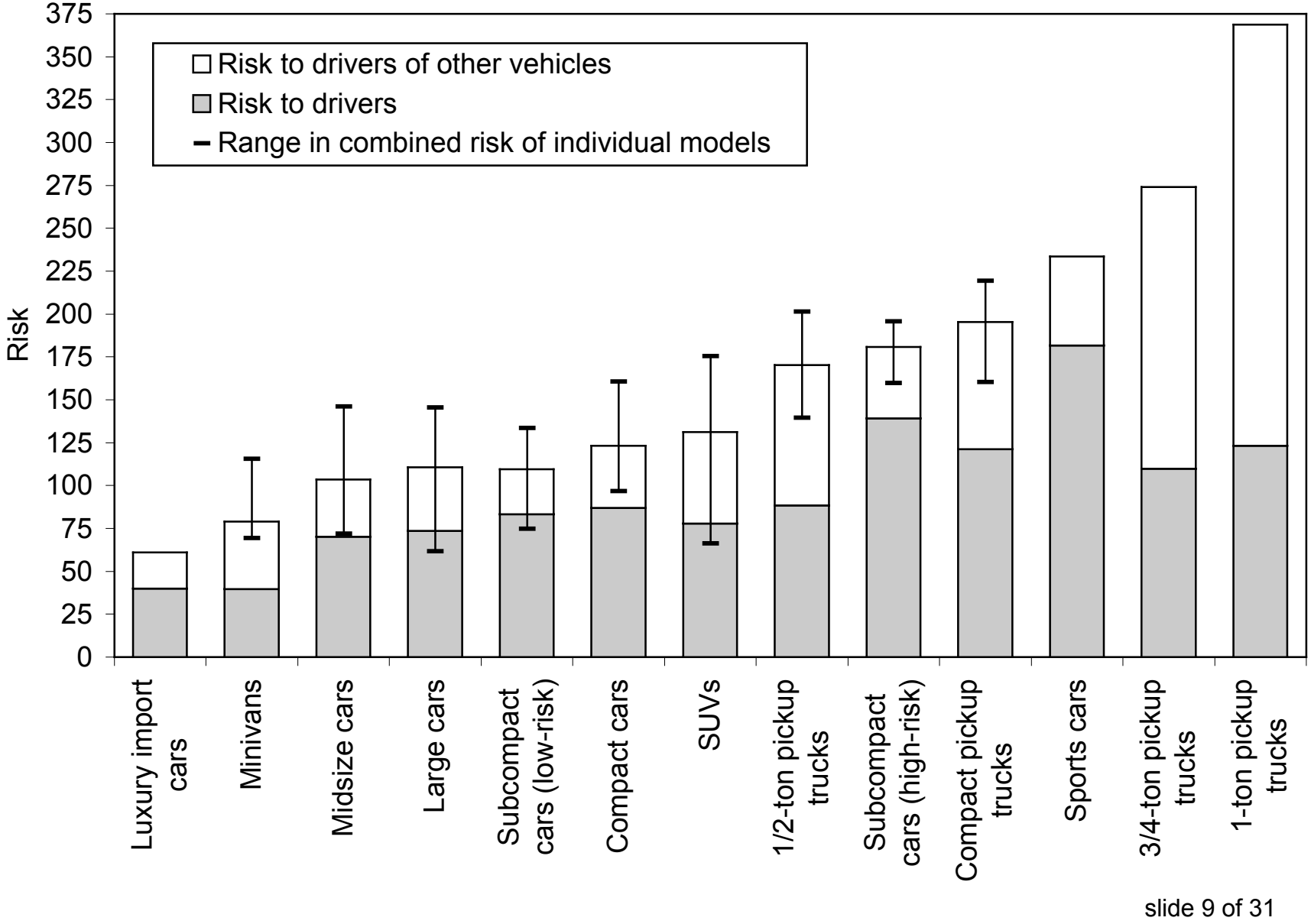
Two types of risk

- Risk to drivers of subject vehicle
  - —from all types of crashes (total, and separately for two-vehicle crashes, one-vehicle crashes, rollovers, etc.)
- Risk imposed by subject vehicle on drivers of other vehicles (all types and ages)
  - —often called vehicle “aggressivity” or “compatibility”
  - —because from two-vehicle crashes only, risks to other drivers tend to be lower than risks to drivers
- Combined risk is the sum of the two

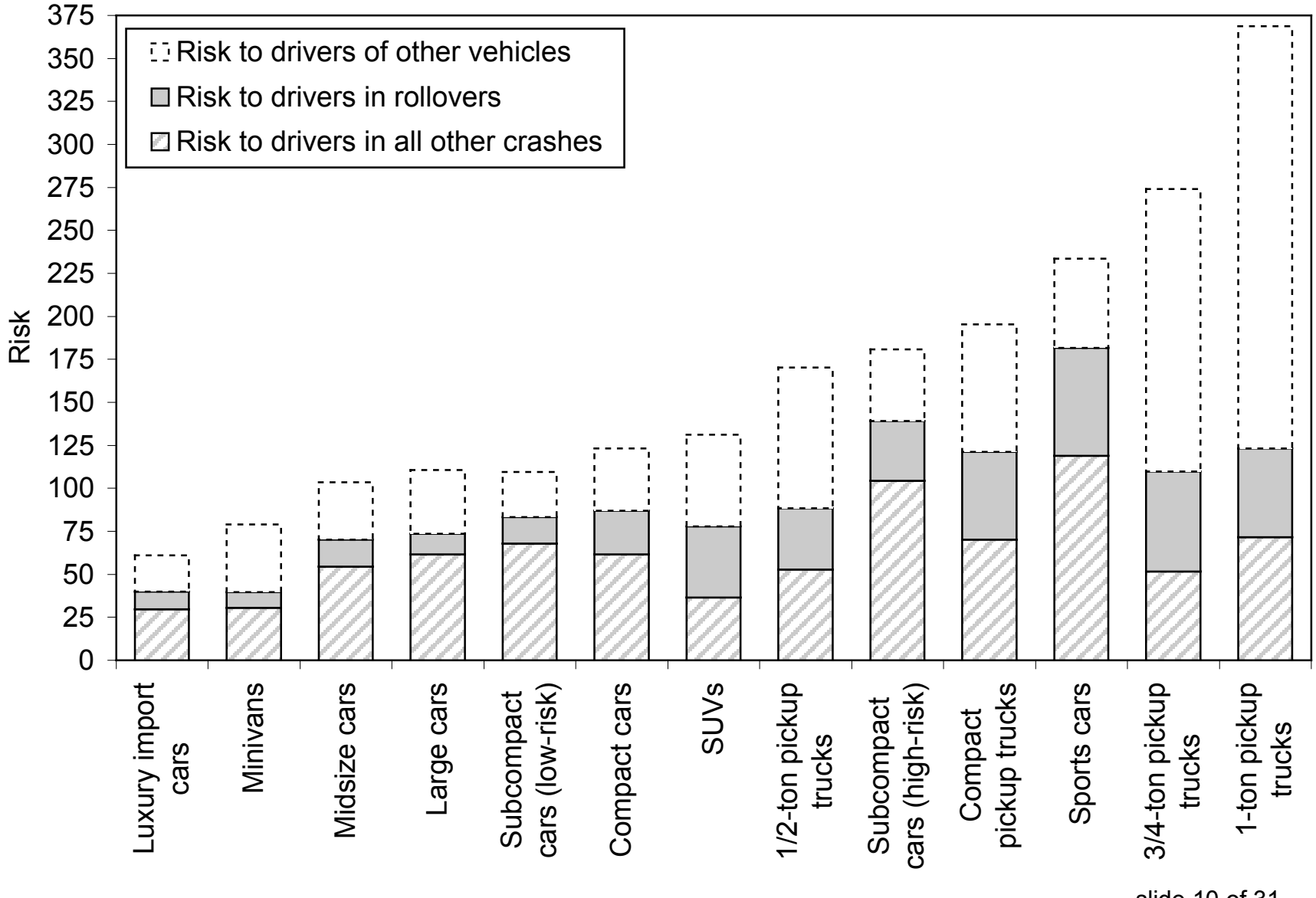
Two levels of analysis

- Risks by vehicle type
  - four major car classes (plus luxury import and sports cars), based on Consumer Guide
  - pickups by size, SUVs, and minivans
  - calculated for 92 popular vehicle models with relatively consistent, strong sales over 1997-2001
  - differences less than ~10% not statistically significant
- Risks by vehicle model
  - calculated using only 49 most popular vehicle models, to reduce statistical uncertainty
  - differences less than ~20% not statistically significant

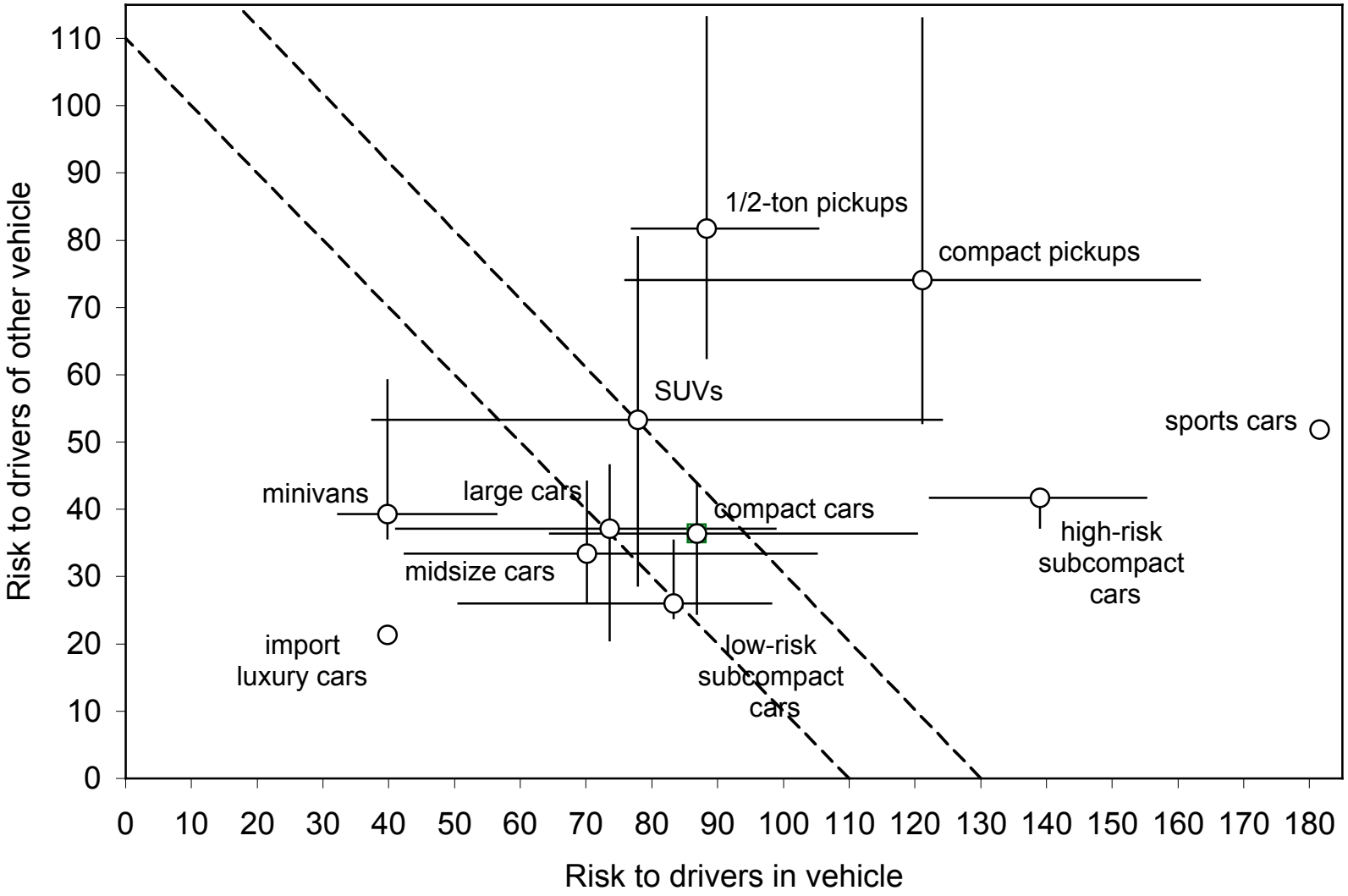
Risks by vehicle type



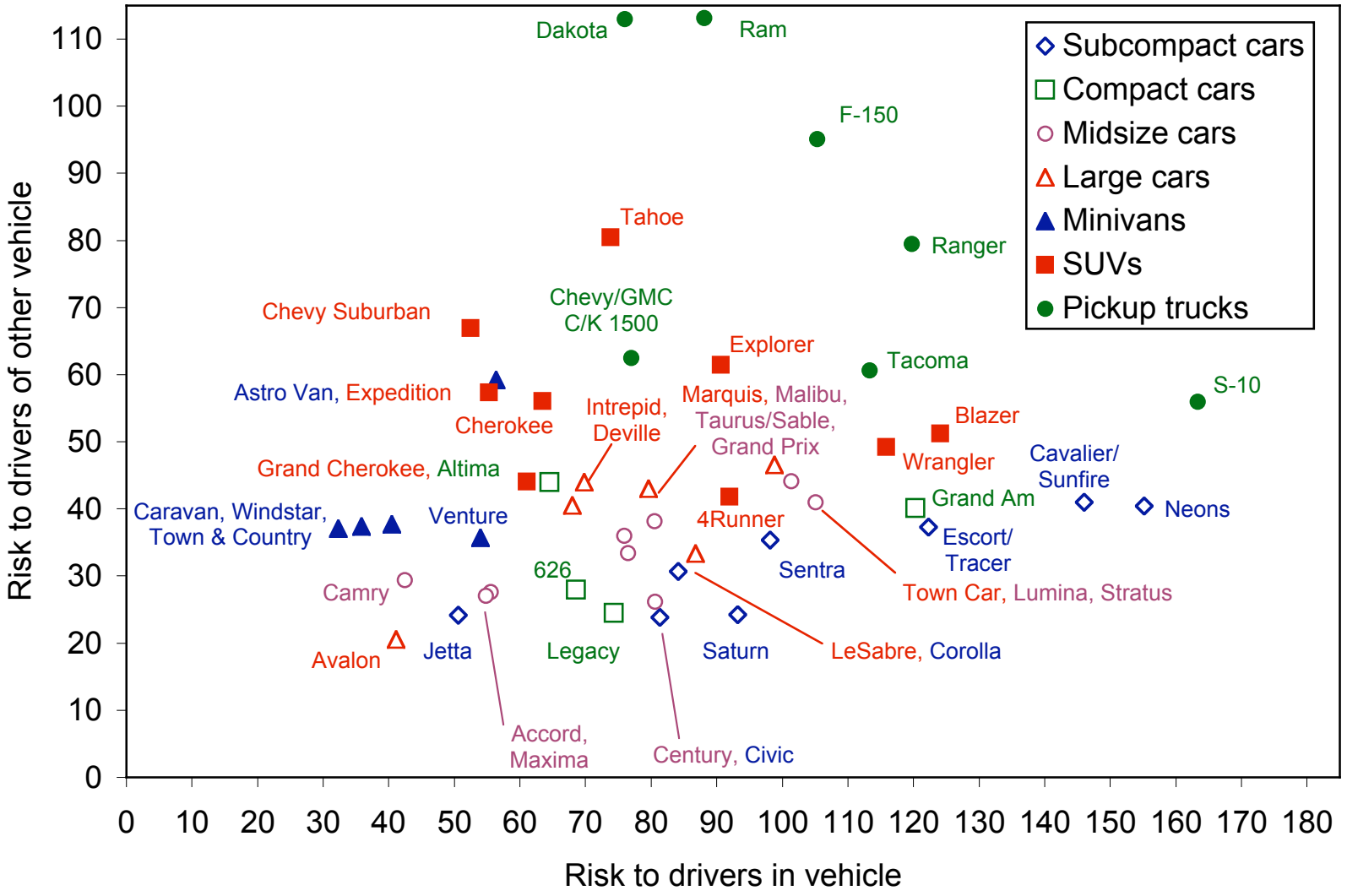
Risk to drivers in rollovers and all other crashes



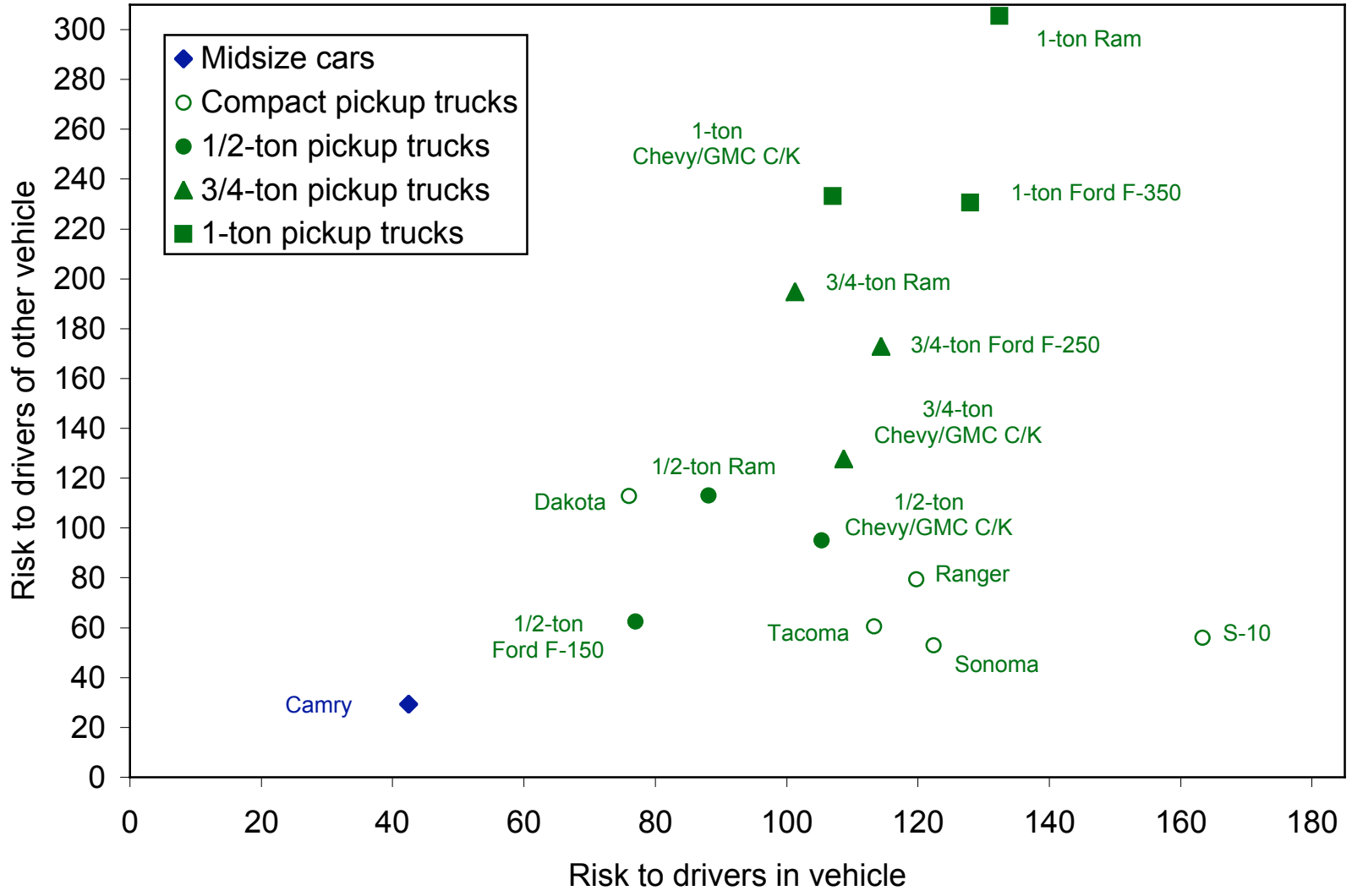
Risks by vehicle type



Risks by vehicle model



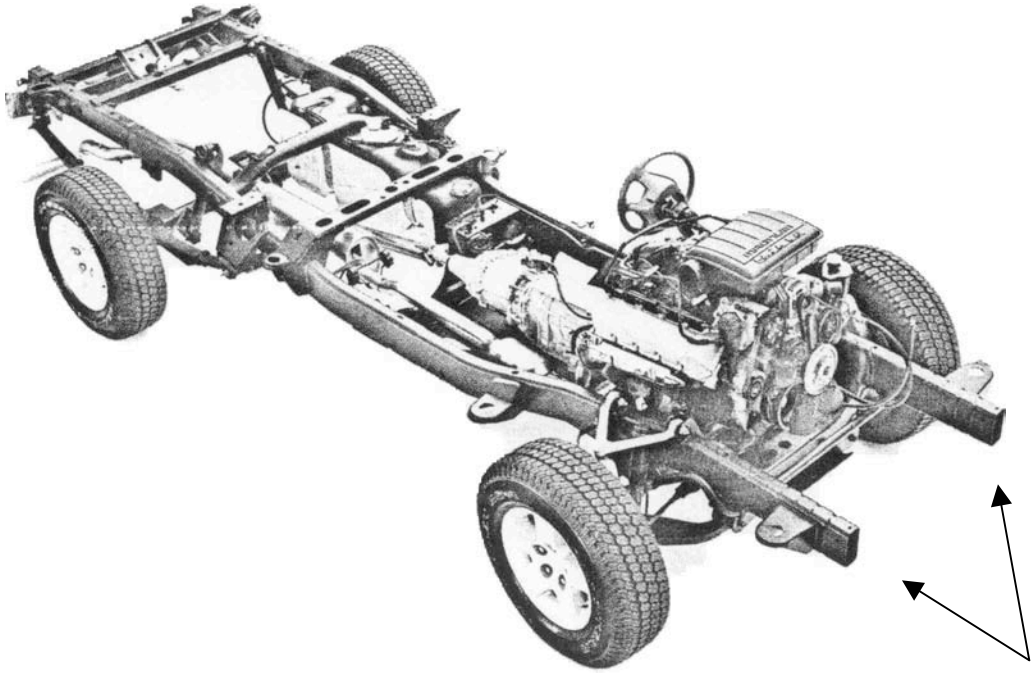
Pickup risks increase with increasing capacity



Effect of vehicle design on risk

- High risk to drivers of pickups and SUVs from their propensity to roll over
  - NHTSA's static stability factor: tw/2h
  - tw = track width; h = height of center of gravity
  - average car SSF is 1.40, 12% chance of rollover in a crash
  - average SUV SSF is 1.15, 28% chance of rollover
- High risk to others from pickups and SUVs (and to a lesser extent minivans) associated with chassis stiffness and height
  - car driver fatality rate is 5x higher when struck in side by SUV (4x higher when struck by pickup) than when struck in side by another car
  - SUVs are built on pickup frames, whose rails can override car bumpers and sills and puncture car bodies

Stiff frame rails of pickups and truck-based SUVs act as fork tines



MY02 Dodge Ram 150 pickup truck

Driver behavior influences risk

- Minivans have lowest risk to drivers, presumably because drivers are more careful (similar results with station wagons v. sedans of same model)
- Sports cars have highest risk to drivers
- Do import luxury cars attract low-risk drivers? Or are they well designed for safety?
- Driver characteristics that affect risk
  - age and sex, driving history
  - seatbelt use
  - alcohol/drug use
  - education level/income
- Environmental variables that affect risk
  - time of day (visibility)
  - weather (road conditions)
  - rural roads (poorly lit and designed, high speeds)

Effect of driver behavior on risk

- Young males (<26) are riskiest drivers; elderly (>65) are most vulnerable drivers
  - need exposure (vehicle sales or registrations) for each group to calculate the risk for each group
  - instead looked at fraction of driver fatalities in each group, by vehicle type
- SUVs have same or lower fraction of young male and elderly drivers than major car types; therefore these high risk/vulnerable drivers do not explain higher risks in SUVs than in cars
- Risky sports cars have highest fraction of young male fatalities (40%), while safe minivans have the lowest (6%)
- Large Big 3 cars have highest fraction of elderly fatalities (50%)
- However, individual models do not necessarily fit these trends
  - the safe Civic (31%) and Jetta (26%) have more young male fatalities than all other subcompacts (21%)
  - the risky Blazer has the same young male fatalities as the average SUV (16%)

Effect of environment on risk

- Rural roads (less well-lit, undivided, higher speeds, unenforced, further from hospital) are less safe than suburban or urban roads
- Pickups are driven more on unsafe rural roads than other vehicle types; average pickup fatality occurs in much less dense areas (300 people per sq mile) than average car or SUV fatality (800 people per sq mile)

Too much “weight” given to flawed study

- National Academy CAFE committee relied on 1997 NHTSA study
  - used complicated procedure to account for many driver and crash characteristics
  - reducing weight of all cars by 100 lbs (holding truck weights constant) increases annual fatalities by 300 (1.13%)
  - reducing weight of all trucks by 100 lbs saves 40 lives (0.26%)
- Several flaws in 1997 study
  - oldest vehicles (mid- to late-1980s) greatly influenced results
  - weight was the only vehicle characteristic studied; size etc. not analyzed
  - assumes historical correlation between weight and size will continue into future (even with more extensive use of new lightweight materials)
- Subsequent research indicates that
  - using newer data results in no change in fatalities from car weight reduction (DRI 2002)
  - reducing car weight while holding size (wheelbase and trackwidth) constant reduced fatalities (DRI 2003)

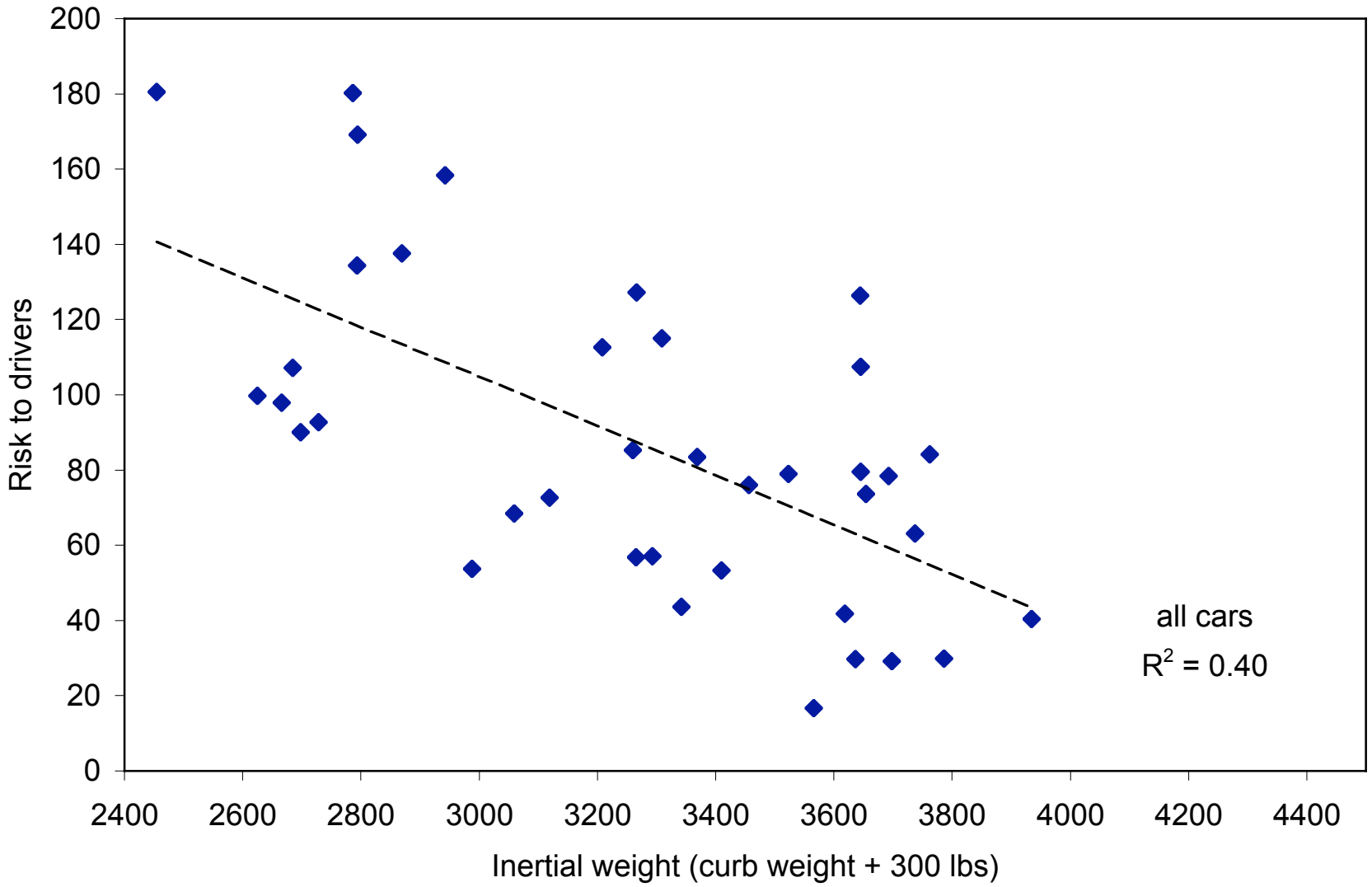
Updated NHTSA analysis (2003) repeats earlier flaws

- New method, using more recent data, results in even more deaths from weight reduction
  - reducing car weights by 100 lbs causes 810 deaths (3.3%)
  - reducing truck weights by 100 lbs causes 305 deaths (1.3%)
  - these estimates do not account for size independent of weight
- On the other hand, finds that a truck's frontal stiffness increases the fatality rate in a head-on collision with a car of the same weight
- Estimates total fatality rates by miles driven
  - we estimate that replacing 80% of pickups and SUVs (used as car substitutes) with midsize/large cars and minivans would have reduced 1999 fatalities by 3,400 (9%)
- NHTSA requesting comments on their analysis by 3/24/2004
  - download report (300 pages!) at: www.nhtsa.dot.gov/cars/rules/regrev/evaluate/pdf/809662.pdf
  - send comments to docket number NHTSA-2003-16318 at: http://dms.dot.gov/reports/fr.htm

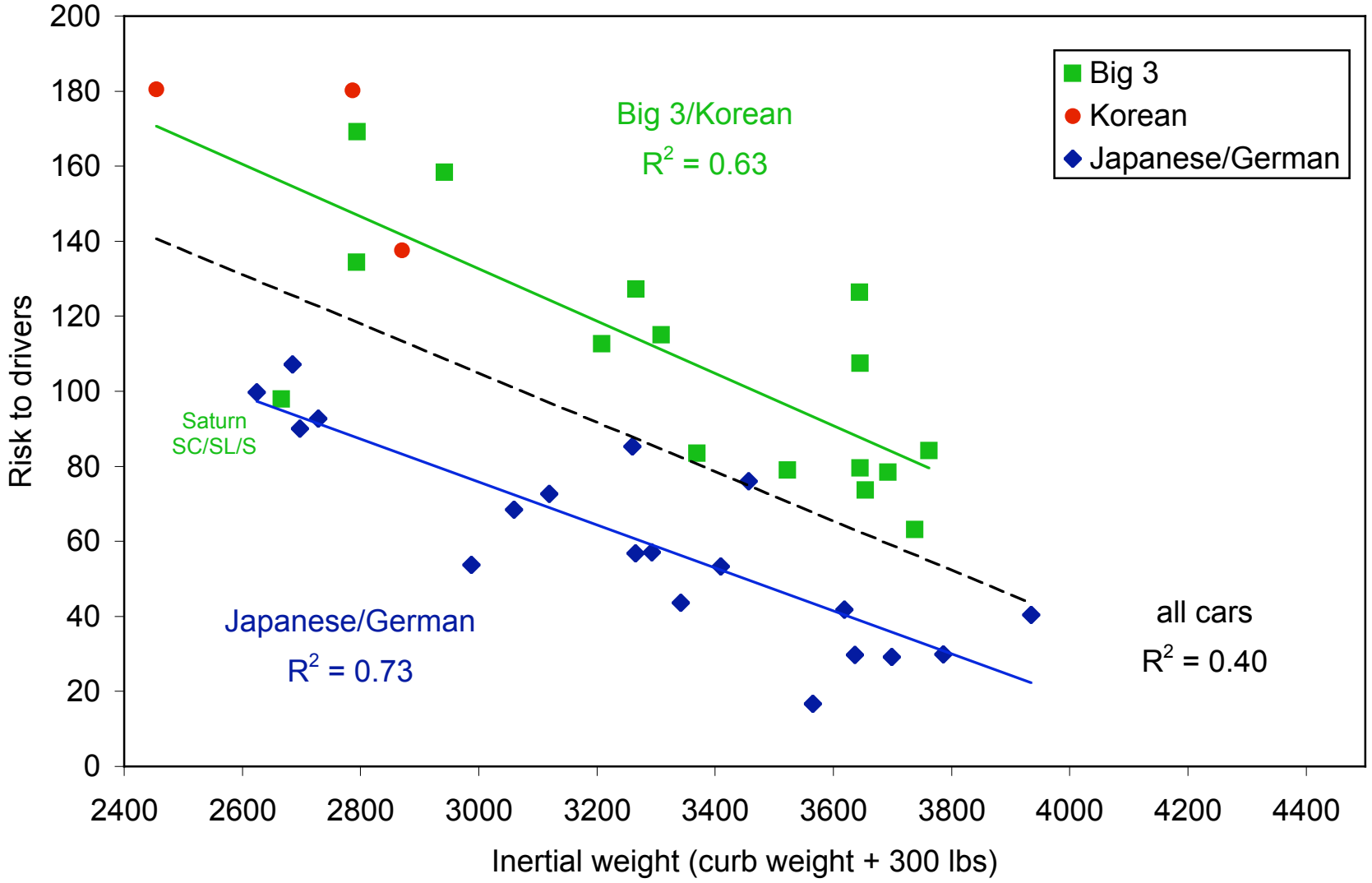
Is car weight the best predictor of risk?

- Quality of vehicle design appears a better predictor of risk than weight
  - —manufacturer
  - —resale value (retail used car price from Kelley Blue Book)
  - —Consumer Reports safety assessment ratings
- Analysis limited to cars; need truck weights by “model” to apply to pickups, SUVs and minivans
- Models overly influenced by their drivers (young males or elderly) excluded from analysis

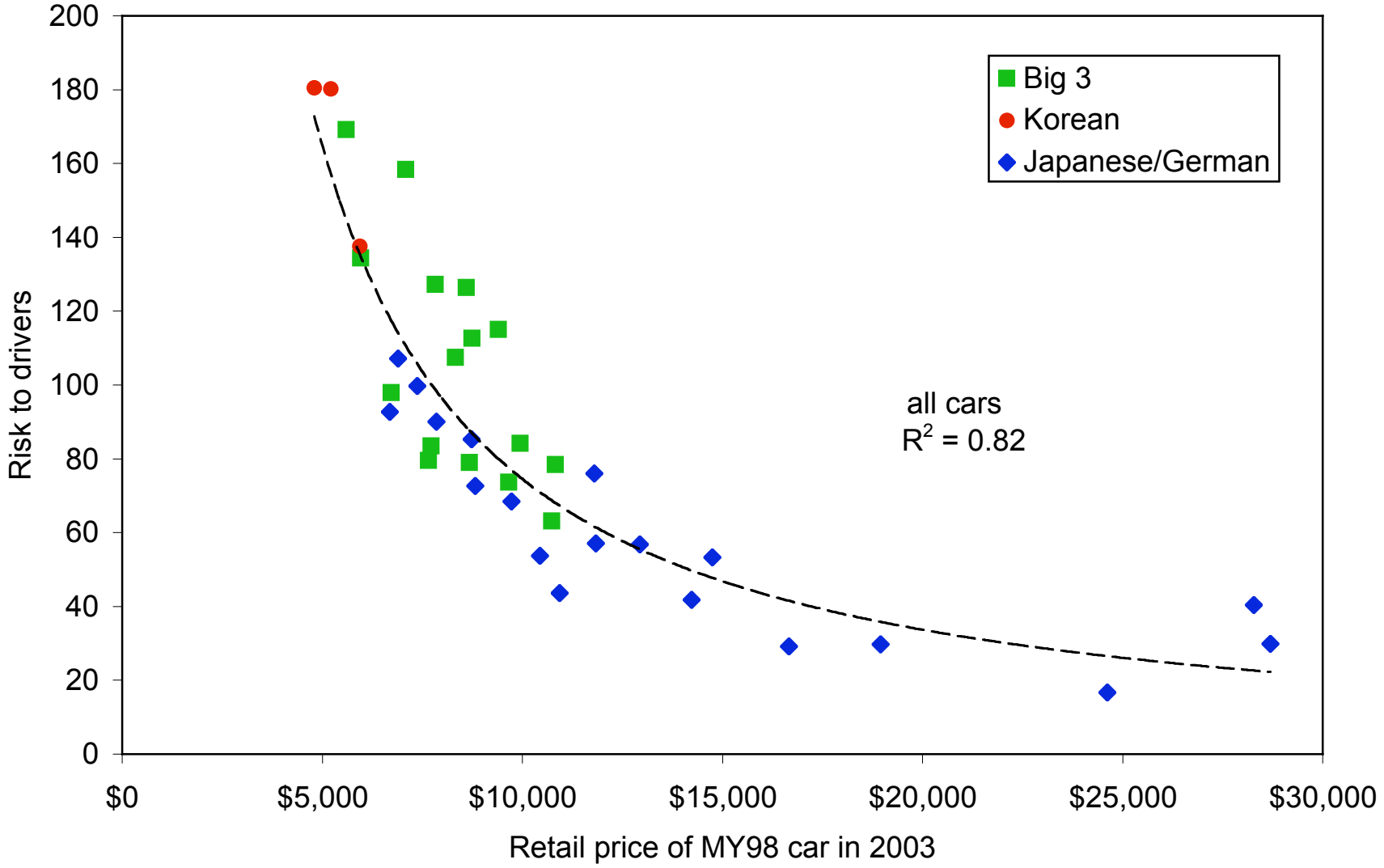
Weak relationship between car weight and risk…



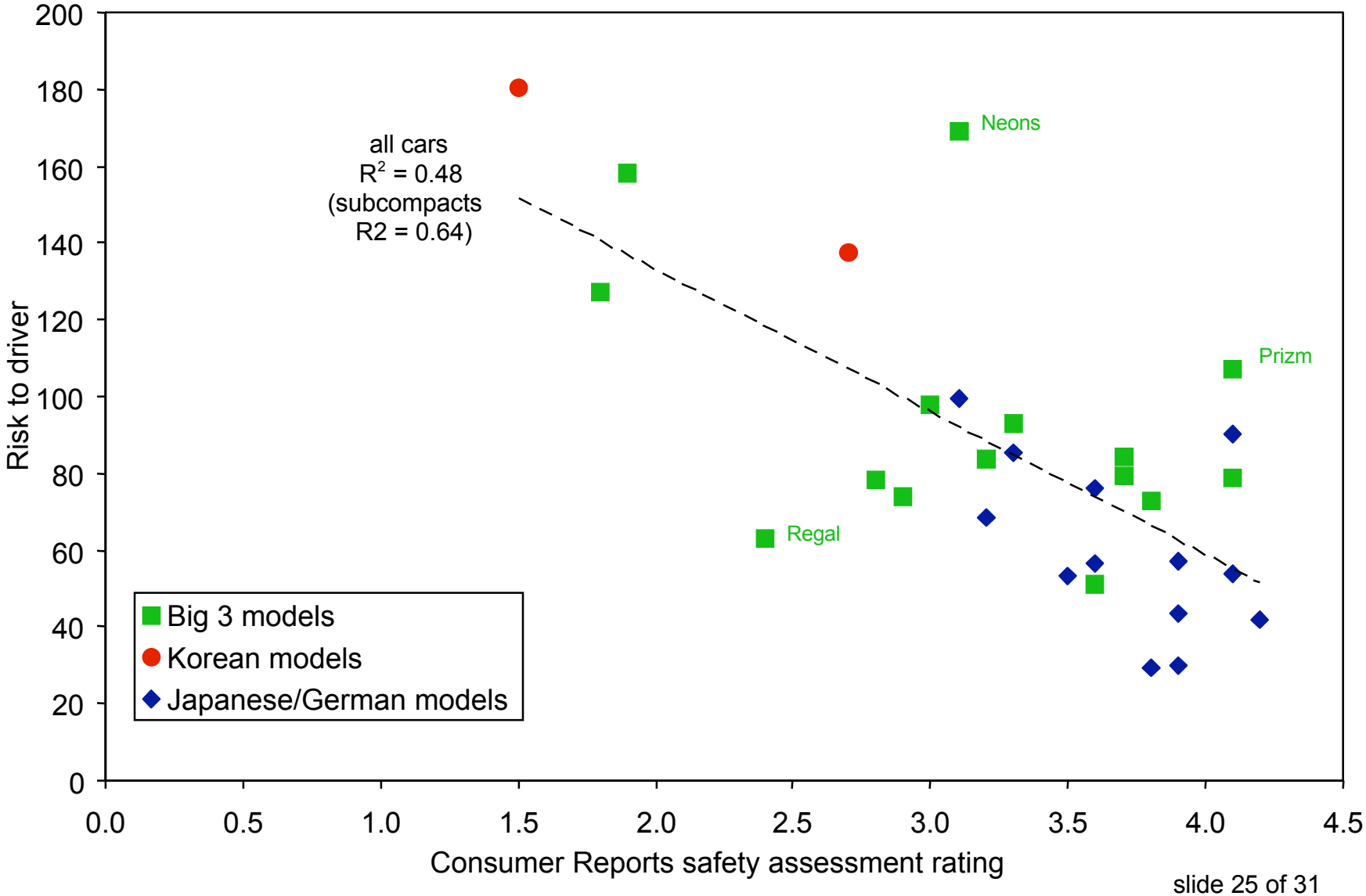
… unless one accounts for manufacturer



Strong relationship between car resale value and risk



Weak relationship between CR safety assessment rating and risk



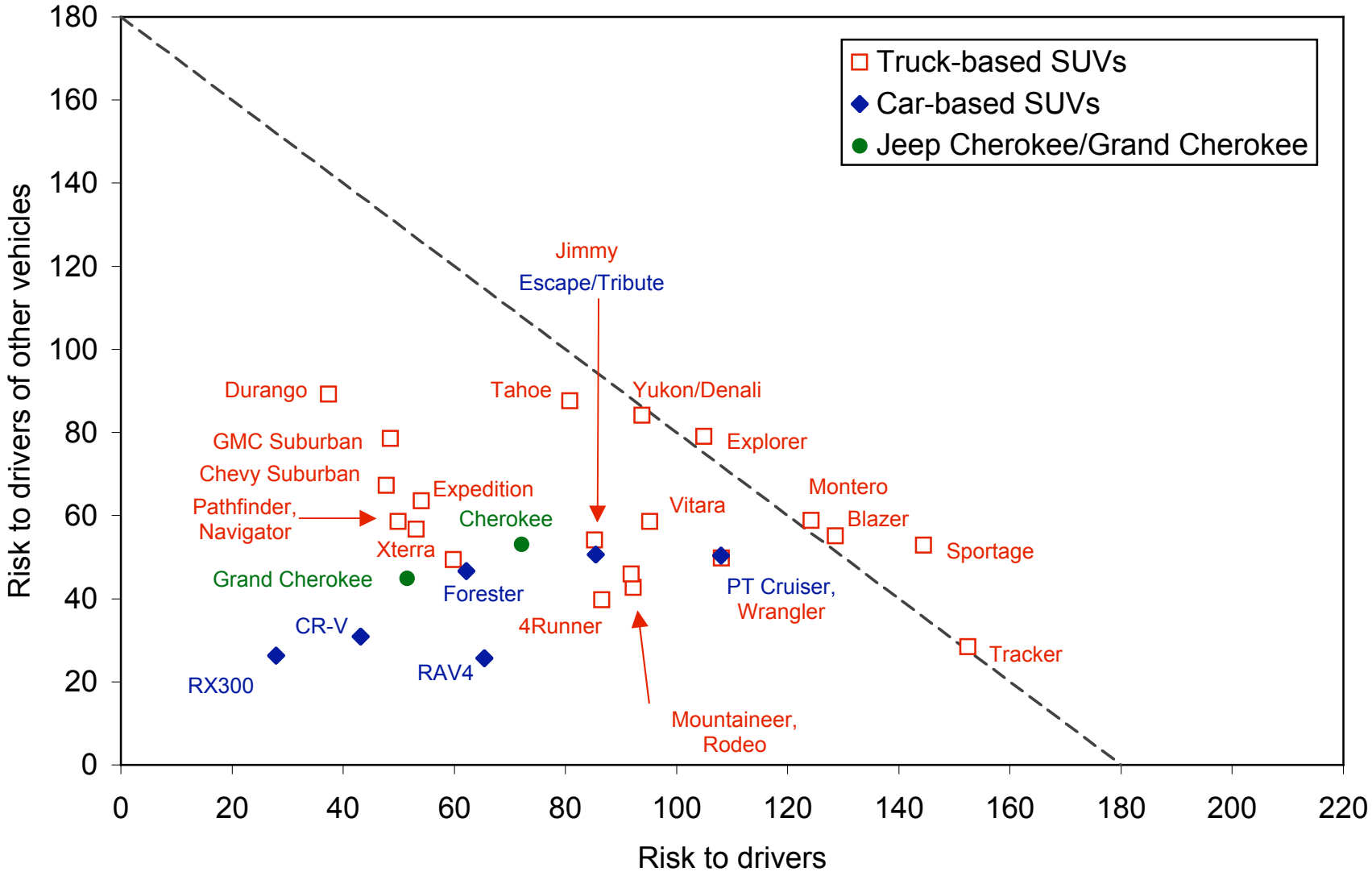
European researchers' view

- "The results from this project have overturned the original views about [car-to-car] compatibility, which thought that mass and the mass ratio were the dominant factors." (Edwards et al., 2001)
- "The scientific community now agrees that mass does not play a direct role in [car-to-car] compatibility." (Delannoy et al., 2003)
- "Moreover, if mass appears to be the main parameter linked to aggressivity of cars [against other cars], it is because this is the easiest and universal parameter that is collected in all accident databases." (Faerber, 2001)
- Intrusion into car (and occupant), rather than occupant striking car interior, is dominant cause of fatality or serious injury
- Therefore, mass in and of itself is not fundamental to safety in two vehicle crashes

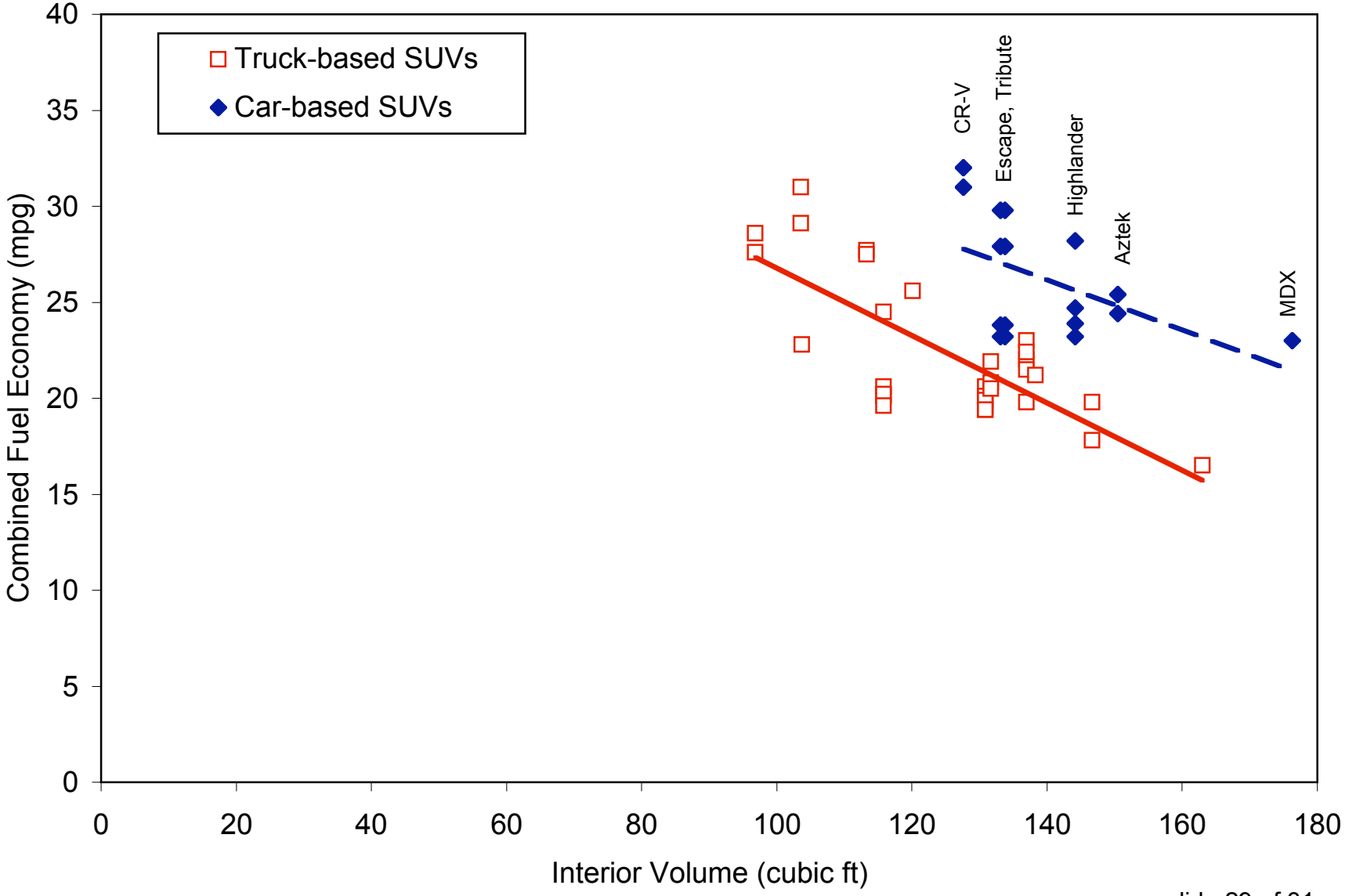
Are crossover SUVs a solution?

- Most conventional SUVs built on pickup chassis, with high/stiff fronts (body-on-frame construction)
- Manufacturers now making “crossover” SUVs built on car-like, unit body chassis
- Crossover design lowers center of gravity (increases stability) and softens front (reduces aggressivity)
- Early data on these crossovers suggests that they are indeed safer, in both dimensions, than truck-based SUVs…
- … and crossovers tend to have 30% higher fuel economy than truck-based SUVs with the same interior volume
- However, the first crossovers are made by the manufacturers that make safe cars; can all manufacturers build crossovers that are safe?

Early car-based/crossover SUVs tend to have lower risks than truck-based SUVs…



… and about 30% higher fuel economy for same interior volume



Summary

- Average car is as safe to its driver as average SUV; some car models as safe or safer than safest SUV models
- SUVs and pickups pose higher risk to others than cars; pickup risk to others increases with size
- Young male and elderly drivers are not influencing the risks in SUVs relative to cars; other more subtle driver differences (income? education?) might be
- SUVs are not driven more than cars in risky rural areas, although pickups are
- NHTSA study “proving” that lighter vehicles are less safe is flawed; we believe that measures of quality of design, such as resale value, better predict vehicle risk than weight. European researchers agree that weight is not the most important variable
- Early crossover SUV models appear to be safer, and more efficient, than truck-like SUVs; quality of their design may be playing role

Other resources

- LBNL reports (including this presentation, eventually)
  - http://eetd.lbl.gov/EA/teepa/pub.html#Vehicle
- NHTSA crash tests (NCAP)
  - http://www.nhtsa.dot.gov/cars/testing/ncap/
- NHTSA CAFE FAQ
  - http://www.nhtsa.dot.gov/cars/rules/cafe/overview.htm
- IIHS driver death rates
  - http://www.hwysafety.org/sr_ddr/sr3507.htm
- Public Citizen vehicle safety
  - http://www.citizen.org/autosafety/
- Don't Be Fueled
  - http://www.dontbefueled.org/
- *High and Mighty: SUVs: The World's Most Dangerous Vehicles and How They Got that Way*, Keith Bradsher